Rainbow Trout Farming: An Economic Perspective

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Fisheries and Marine Service

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by

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ABSTRACT

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Extensive aquaculture in prairie pothole lakes is a relatively new industry in Western Canada. It is characterized by a high turnover rate of entrepreneurs entering and leaving the industry. Risk of financial failure appears high due to variability in recovery rates of stocked fingerlings. Many participants treat the industry as a hobby.

Investment in rainbow trout fish farming as a commercial venture is examined. Given the potential biological productivity of an individual lake, gross revenues, investment requirements, owning and operating costs are determined. Financial break-even points on annual production and on fishing effort, sales and profitability ratios and the net present value of an enterprise's cash flow are calculated.

Key words: aquaculture; freshwater aquaculture; Prairie: commercial fishing; economics; cost analysis; break-even analysis; feasibility.

RESUME

Cauvin, D.M., and P.C. Thompson, 1977. Rainbow trout farming: An economic perspective. Can. Fish. Mar. Serv. Ind. Rep. 93; iv + 24 p.

L'aquiculture extensive dans les étangs naturels (potholes) des prairies est une industrie relativement nouvelle dans l'ouest Canadien. Une des ses caractéristiques est le peu de stabilité des investisseurs; le taux de renouvellement est très élevé. Le risque d'échec est grand car la récuperation des alevins transplantés est très variable. Parmi ceux qui participent à cette industrie, bon nombre la considère comme une sorte de passe-temps.

On procède ici a l'examen de la culture de la truite arc-en-ciel dans les étangs en tant qu'investissment financier. Lorsqu'on connaît le potentiel biologique d'un étang, il est possible de déterminer les revenus bruts, les investissements requis, les coûts de propriétés et d'exploitation. A partir des données sur la production annuelle et l'effort de pêche, on peut calculer le point nul où il n'y a ni perte ni profit, les rapports entre ventes et profits en somme la rentabilité de l'enterprise.

Mots-clés: aquiculture; aquiculture en eaux douces; Prairies: pêche commerciale; économie; analyse des coûts; étude du seuil de rentabilité; faisabilité.

INTRODUCTION

In 1968, the Freshwater Institute initiated an Aquaculture Research Program in the prairie "pot-hole" lakes area of Western Canada. The initial objectives of the program were "to determine the feasibility of using small prairie lakes for the raising of an annual crop of fish of commercial value, to attempt to define the lake types which are most likely to be of use and the conditions under which a successful crop of fish can be grown" (Johnson et al. 1970). Since 1968, the program has expanded to encompass water chemistry, primary and secondary production, fish population dynamics, genetics and selective breeding.

Paralleling with the development of the Aquaculture Research Program, the infrastructure of an "infant" fish farming industry has emerged. Between 1970 and 1975 the number of licences and permits issued to individuals engaging in fish farming in Alberta, Saskatchewan and Manitoba increased from 397 to 3,813 (Sunde 1975, Lark 1976). Stated briefly, fish farming consists of stocking 6.4 to 7.6 centimeter (2½ to three inch) fingerlings, primarily rainbow trout, in selected lakes in early spring soon after break-up and harvesting the fish in October and November. The pot-hole lakes of Western Canada are extremely productive due to the abundance of natural food, primarily freshwater shrimp (*Gammarus lacustris*), and during the six month period between planting and harvesting the growth of rainbow trout is remarkable, reaching a marketable size of 25.4 to 35.6 centimeters (10 to 14 inches) without supplementary feedings. During the ensuring winter, unharvested fish "winterkill" due to oxygen depletion in the water following ice formation. This situation eliminates potential predators and permits the annual stocking and cropping of fish.

During the past few years, there has been an interest in investing public funds to promote the development of the fish farming industry in Western Canada. The economic implications of expanding an extensive aquaculture program beyond the realm of research and into the private sector are extremely important. Not only is there a risk taken by the individual entrepreneur who embarks on a fish farming enterprise, but there is a risk associated with the investment in public funds. To date, there has been considerable variability in the ability of individual pot-hole lakes to produce a predictable annual yield. Variability of yield has been experienced not only by individual fish farmers, but has also been experienced in the research conducted by the Freshwater Institute. The risk associated with annual yield is regarded as a critical factor, and is considered to be a major deterrent to the immediate development of extensive aquaculture. The aquaculture research program of the Freshwater Institute is currently studying the factors associated with the variability in annual yield with the intention of eliminating the problem, and/or developing a classification system of lakes according to productive capacity and risk.

STATEMENT OF PROBLEM

The success of commercial fish farming will depend, in part, on the aggregate success of individual fish farmers. Partial evidence suggests that, despite the increase in individuals engaging in fish farming, the "turnover" rate of fish farmers, entering and leaving trout farming, may approximate sixty percent. Although the reason for the turnover is not completely understood, it is possible that it is related to the financial failure of fish farming enterprises. The variability in recovery rates of stocked fingerlings that is exhibited by individual lakes poses some serious questions as to the economic feasibility of investing in a rainbow trout farming enterprise. The profitability of a fish farming operation is directly dependent upon the level of yield recoverable from harvesting operations and the associated costs and revenues. Reports of financial losses among individual fish farmers suggests that the financial requirements and prospective returns to labour and capital be completely understood before aquaculture is promoted by government. An analysis is required of the financial feasibility of investing in a fish farming enterprise.

STUDY PROPOSAL

The analysis of financial returns to an individual fish farming enterprise will provide a framework for assessing the feasibility of investing in rainbow trout farming. Given the potential biological productivity of an individual lake, it is possible to identify gross revenues, investment requirements, and owning and operating costs. Costs and revenues thus generated will permit the following analysis:

1. Analysis of annual income and expenditures.
2. Break-even analysis of annual production.
3. Break-even analysis of production per unit of fishing effort.
4. Analysis of investment in aquaculture.

Analysis of annual income and expenditures

Annual income statements constructed for a 8.1 hectare (twenty acre) lake for the 1974 and 1975 operating seasons will provide the necessary data for an analysis of annual income and expenditures. This information will permit an accounting evaluation of the annual financial performance of a fish farming enterprise, including an assessment of net profit, cash flow and cash balance. In addition, the cost and revenue data, underlying the income statements, will provide the information for the subsequent break-even and investment analysis.

Break-even analysis of annual production

Break-even analysis is used to determine the level of yield at which income will just cover expenses. Figure 1 illustrates graphically the percentage recovery needed to cover fixed and variable costs. Based on the data contained in the income statements, it is possible to estimate fixed costs, variable costs and sales for different levels of production. This information will provide the basis for analysing the

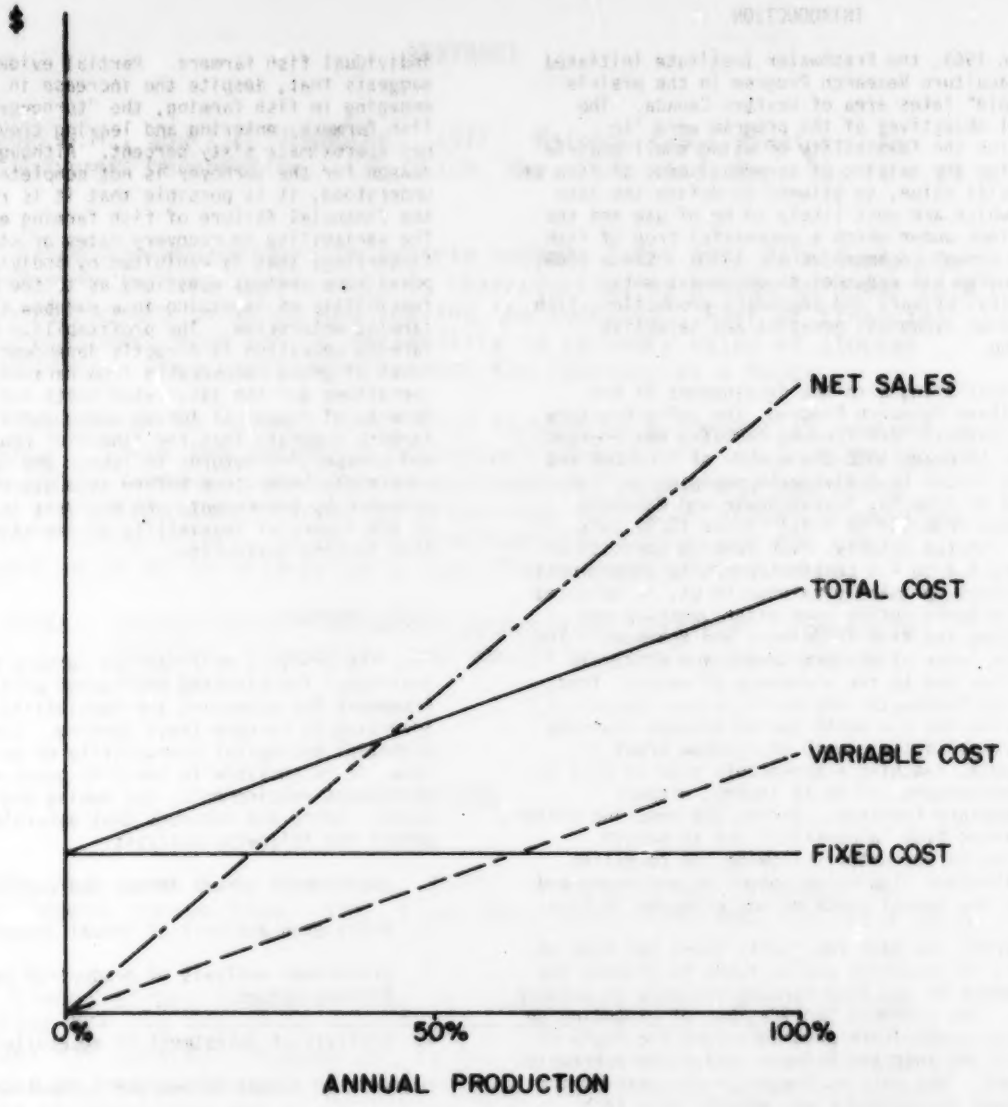

Fig. 1 Break-even analysis: Annual production.

percentage recovery of stocked fingerlings that will be required to cover costs.

Break-even analysis of production per unit of fishing effort

It has been observed in rainbow trout harvesting operations that the yield of fish per night diminishes with each successive set and lift of nets. Thus, total production and thus total income, increases at a decreasing rate during the harvest operation. This phenomenon is illustrated graphically in Figure 2. The question that naturally arises from this situation is: at what point in the harvesting operation does it become uneconomic to continue setting and lifting nets?

Again, break-even analysis may be used to determine the point at which the cost of fishing effort exceeds the value of production. The relationship between the value of production and the cost of production is illustrated in Figure 3. While total revenue from the sale of fish increases at a decreasing rate corresponding to total production, the daily value of production (marginal value product) decreases in accordance with the diminishing yield of fish per net night. Similarly, total costs increase at a decreasing rate with each successive set and lift of nets. This situation is attributable to the daily variable cost of production (marginal factor cost) which decreases with each successive lift and set of nets as the amount of fishing effort declines to a minimum level in accordance with diminishing production. Two points are relevant. The point at which accumulated total revenue is intersected

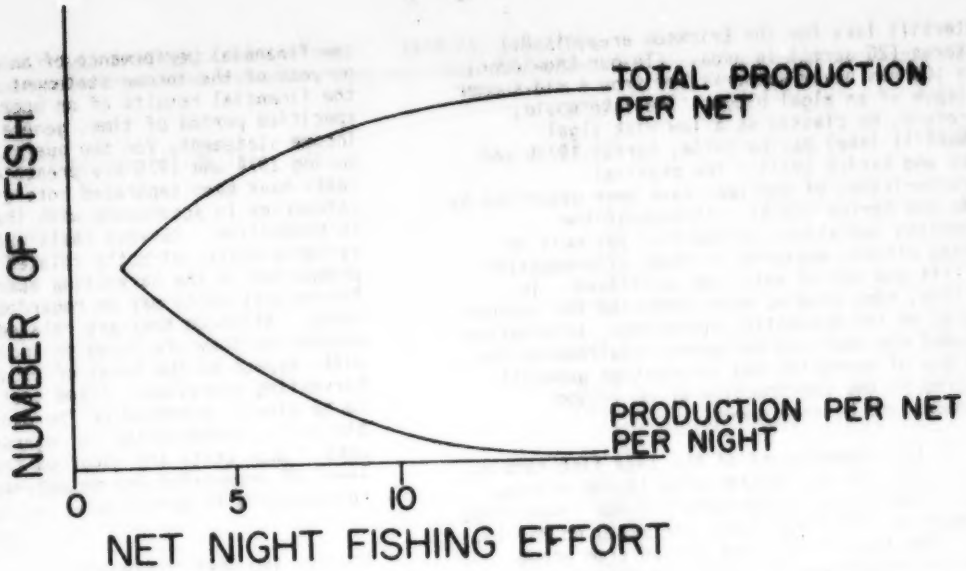

Fig. 2. Production per unit of fishing effort.

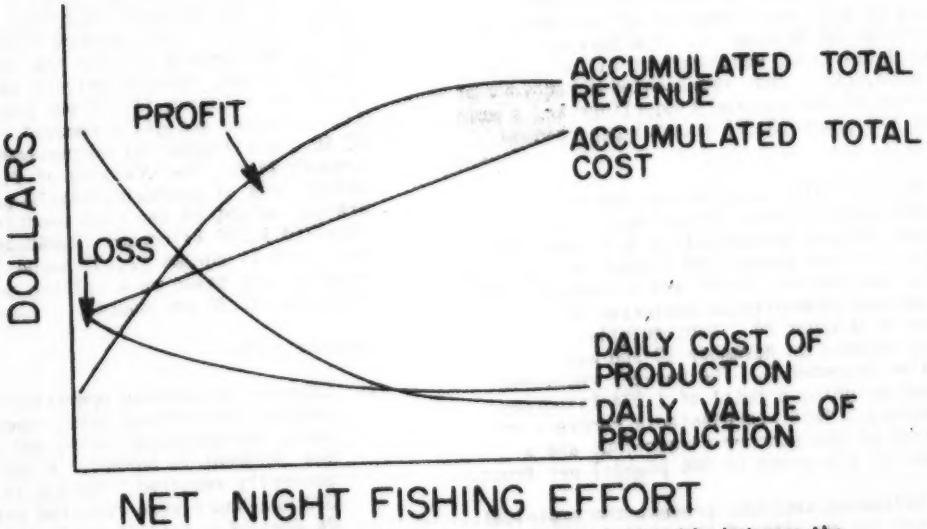

Fig. 3. Break-even analysis showing the relationship between the daily cost and value of production.

by accumulated total costs is the breakeven point where accounting profits are zero, while the point where daily revenue is intersected by daily costs is the point where profits are the greatest and the harvest operation should be terminated.

Analysis of investment in aquaculture

The evaluation of an annual income statement and the resultant break-even analysis represents an intermediate judgement of the financial viability of a fish farming enterprise. The consequences of investment over a period of time are of critical importance. A proforma statement constructed on the basis of anticipated recovery will permit an evaluation of the expected financial performance of Lake 106 over a ten year period. The annual net revenue thus generated will provide an estimate of the value of the lake for rainbow trout production. This analysis is considered to be essential to assess the financial feasibility of investing in aquaculture. The format for analysis may be applied to lakes of any size or productive potential.

FIELD PROCEDURE

During the 1974 and 1975 harvest periods, the Fishing Services Branch assisted in the harvest of Lake 106, located eight kilometers (five miles) south of Erickson, Manitoba (Section 8, Legal Subdivision 6, Township 17, Range 18, West of the Principal Meridian). Lake Number 106, a typical

winterkill lake for the Erickson area, is 8.1 hectares (20 acres) in area. (To our knowledge, Lake 106 has never summerkilled from a mid-summer collapse of an algal bloom. The lake would, therefore, be classed as a low risk algal summerkill lake) Barica 1975a, Barica 1975b and Ayles and Barica 1977). The physical characteristics of the lake have been described by Sunde and Barica (1975). Throughout the harvesting operations, production per unit of fishing effort, measured in terms of production per lift and set of nets, was monitored. In addition, time studies were conducted for various aspects of the harvesting operation. Information included man-hour and equipment requirements for each day of operation and information generally required in the construction of an income statement and balance sheet.

At the commencement of the 1974 fish farming season Lake 106 was stocked with 12,000 rainbow trout fingerlings, approximately 1,500 fingerlings per hectare (600 fingerlings per acre) on May 15, 1974. The fingerlings were raised from brood stock in the Freshwater Institute hatchery at Rockwood, Manitoba. At the time of planting the fingerlings weighed approximately 2.2 grams per fingerling (206 fingerlings per pound) and ranged in length from 5.7 to 6.4 centimeters (2¼ to 2½ inches). After a growing season of 137 days harvesting by gill net commenced on September 29 and terminated on October 30. The harvest recovered 9,524 trout weighing a total of 1,623 kilograms (3,579). This represented a recovery of 79.4 percent of the stocked fingerlings and a mean weight of 170 grams (0.375 pounds) per rainbow trout.

On May 13, 1975, Lake 106 was again stocked with 12,000 rainbow trout fingerlings. The fingerlings weighed approximately 3.9 grams per fingerling (116 per pound) and ranged in size from 7.0 to 7.6 centimeters (2-3/4 and 3 inches). The initial harvest commenced on September 29 and terminated on October 24. Subsequently, harvesting resumed on November 28 and was completed on December 5. The harvest recovered 7,647 trout weighing a total of 1,334 kilograms (2,941 pounds). This represented a recovery of 63.7 percent of the stocked fingerlings and a mean weight of 175 grams (0.386 pounds) per trout.

The following sections present the empirical analysis and the results of the study. Section 2 is concerned with the construction and analysis of income statements for the 1974 and 1975 operating years. Section 3 provides a perspective of annual production required to break even. Break-even analysis in relation to the termination of fishing effort is the subject of section 4. A proforma statement is developed in section 5 to assess the consequences of investment in aquaculture over a ten year period. Finally, the prospects for the development on an aquaculture industry are discussed briefly in section 6.

ANALYSIS OF ANNUAL INCOME AND EXPENDITURES

INCOME STATEMENT

An income statement is a formal accounting information system that provides a "snapshot" of the financial performance of an enterprise. The purpose of the income statement is to illustrate the financial results of an operation for a specified period of time, generally a fiscal year. Income statements for the operation of Lake 106 during 1974 and 1975 are presented in Table 1. Costs have been separated into direct and indirect categories in accordance with their relationship to production. Harvest costs are regarded as variable costs, directly related to the level of production in the harvesting operation. Pre-harvest costs may be regarded as semi-variable costs. Although they are related to annual production they are fixed or indirectly related with respect to the level of production in the harvesting operation. Fixed costs are considered to be direct, overhead or "burden" costs. Similarly, depreciation is regarded as an indirect cost. Such costs are incurred regardless of the level of production and do not vary in relationship to production.

REVENUE AND COST COMPONENTS

Trout sales

Production from Lake 106 during the 1974 and 1975 harvest seasons was 1,623 kilograms (3,579 pounds, 9,524 rainbow trout) and 1,334 kilograms (2,941 pounds, 7,641 rainbow trout) respectively. During this period of time the selling price for rainbow trout, through private sale, approximated $2.87 per kilogram ($1.30 per pound) for dressed fish (viscera and gills removed, head on) and $2.20 per kilogram ($1.00 per pound) for whole (round) fish. The dressing of fish entails a weight loss of approximately 20 percent. The dressed weight of the fish produced, therefore, equalled 1,299 kilograms (2,863 pounds) in 1974 and 1,067 kilograms (2,353 pounds) in 1975. Gross revenues are based on a selling price of $2.87 per kilogram ($1.30 per pound).

Harvest costs

1. Labour: Harvesting operations consist of setting and lifting nets, removing trout from nets, and dressing, icing and packing trout for shipment to market. A two man crew is generally required. During 1974 a total of 373 man-hours were required over a period of 26 days of actual fishing activity to complete the harvest. Total man-hours can be broken down into two components. Lifting and setting nets and removing fish from nets required 205 man-hours. Dressing, icing and packing fish for shipment to market required 95 man-hours, while the remaining labour was spent in marketing the trout. (A considerable variability exists in dressing rainbow trout. Man-hour requirements have been estimated on the basis of 100 rainbow trout per hour dressed with head on. An expert at dressing fish would undoubtedly double this production.) In 1975 a total of 340 man-hours were required to complete the harvest, over a period of 29 days of actual fishing activity. Lifting and setting nets and removing fish from nets required 197 man-hours. Dressing, icing and packing fish for shipment to market required 76 man-hours. Harvest labour costs are based on the Manitoba minimum wage rate of $2.15 per hour in 1974-1975.

Table 1. Rainbow trout farming income statement - 1974-75, Lake 106.

	1974	1975
Trout Sales @ $2.87/kilogram ($1.30/lb.)	$3,722	$3,059
Harvest Costs		
Harvest Labour	646	588
Transportation	80	70
Ice	110	90
Marketing	359	382
	-1,195	-1,130
Gross Profit	2,527	1,929
Pre-Harvest Costs		
Copper Sulphate	60	60
Pre-Harvest Labour	54	34
Transportation	18	13
Fingerlings	672	828
	-804	-935
Gross Operating Profit	1,723	994
Indirect Costs		
Commercial Fish Farming Licence	15	15
U.I.C., C.P.P. & W.C.	21	19
Insurance	39	39
	-75	-73
Net Operating Profit	1,648	921
Depreciation Expense		
Boat	78	66
Outboard Engine	231	162
Gill Nets	102	82
Tubs	17	13
Ice Equipment	15	12
	-443	-335
Net Profit	1,205	586
Income Tax	301	147
Net Income	904	439
Cash Flow		
Net Income	904	439
Depreciation	443	335
Total Cash Flow	1,347	774
Cash Balance		
Net Profit	904	439
Depreciation	443	335
Operator's Wages	471	430
	1,818	1,204

2. Harvest Transportation Costs: Variable costs associated with harvest transportation include the owning and operating costs for a truck and the operating costs for an outboard engine. A fish farmer will generally require a one-half ton or a three-quarter ton truck as a part of his main or traditional farming enterprise. For accounting purposes, it is an acceptable convention to charge the cost of a vehicle to fish farming in accordance with the distance travelled in the conduct of that activity. In 1974, a total of 674 kilometers (420 miles) were travelled in the process of lifting and setting nets. During the 1975 harvest period a total of 606 kilometers (378 miles) were travelled in the course of the harvesting operation. The cost of a three-quarter ton truck for harvesting operations has been calculated on the basis of $0.10 per kilometer ($0.16 per mile).

   Operating costs for an outboard motor have been estimated on the basis of hourly fuel consumption. Total running times for an outboard motor in 1974 and 1975 were estimated at 16 hours and 50 minutes and 9 hours and 45 minutes respectively. (The difference in the number of hours of running time may be attributed, in part, to the fact that fishing for 8 of the 29 days in 1975 was conducted through the ice.) Operating costs for an outboard motor have been estimated at $0.53 per hour.

3. Marketing Costs: The transport of fish to market entails a transportation and labour expense. Trout farmers are not required to sell their product through the Freshwater Fish Marketing Corporation. As such, there is no formal marketing procedure. In some instances, customers are reported to travel to a farmer's residence to purchase fish. Certain fish farmers are reported to sell their product to Winnipeg hotels. Similarly, rainbow trout have been transported to Brandon for direct sale to residents of Brandon. In these situations the cost of transport to market varies widely. In the interest of identifying marketing as a real cost, it is assumed that the rainbow trout are shipped to a ready market in Brandon, a round trip of 62 kilometers (100 miles), involving three hours driving and transaction time. Based on a transportation cost of $0.10 kilometer ($0.16 per mile) and a labour cost of $2.15 per hour, marketing costs would total $22.45 per trip. During the initial period of harvest, fish is transported to market daily. As production declines over the season, however, the trip to market is undertaken every second day, depending on the level of harvest. At $2.87 per kilogram of dressed fish, a minimum of 8.2 kilograms (18 pounds) of fish must be sold to cover marketing costs. It is estimated that a total of 16 trips were required in 1974 and 17 trips in 1975 to market the rainbow trout.

4. Ice: To ensure proper quality of fish, it is estimated that one kilogram of ice is required per kilogram of fish packed during open water fishing. The commercial price of chipped ice is estimated to be $0.07 per kilogram ($0.03 per pound). In 1974, the cost of ice is based on the whole weight production of 1,623 kilograms (3,579 pounds) of fish. During 1975, 1,252 kilograms (2,761 pounds of fish were produced during the open water season and 82 kilograms (180 pounds) were harvested by fishing through the ice. Total ice requirements for this year have been calculated at 1,252 kilograms (2,761 pounds) during the open water season and 41 kilograms (90 pounds) during the period when fishing was conducted through the ice.

Pre-harvest costs

1. Pre-harvest Labour: Pre-harvest labour encompasses winter lake monitoring, stocking of fingerlings, summerkill prevention and sampling for size and flavour. Experience indicates that 9 hours are required for winter lake monitoring, 8 hours for stocking, 6 hours for summerkill prevention and 2 hours for pre-harvest sampling. In 1974, 25 hours at $2.15 per hour were required for pre-harvest labour. In 1975, excluding the necessity for winter monitoring, 16 hours were required.

2. Fingerlings: The cost of fingerlings through commercial sources was $56.00 per thousand fingerlings in 1974. In 1975, the cost increased to $69.00 per thousand fingerlings. Total cost is based on a stocking of 12,000 fingerlings each year.

3. Pre-harvest Transportation: Paralleling pre-harvest labour, pre-harvest transportation expenses include the use of a vehicle for winter lake monitoring, stocking of fingerlings, summerkill prevention and pre-harvest sampling. Estimates of transportation expenses for a three quarter ton truck are based on the requirement for three trips totalling 48 kilometers (30 miles) for winter lake monitoring (incurred in the first year, 1974 only), 32 kilometers (20 miles) to pick up and stock fingerlings, five trips totalling 80 kilometers (50 miles) to monitor for summer-kill, and 16 kilometers (10 miles) for pre-harvest sampling. In 1974, pre-harvest transportation costs are based on 176 kilometers (110 miles) at $0.10 per kilometer ($0.16 mile). In 1975, excluding winter lake monitoring, pre-harvest transportation costs are based on a total of 128 kilometers (80 miles).

4. Copper Sulphate: Copper sulphate has been successfully used for the purpose of controlling algal growth to prevent summerkill. One application of 5.6 kilograms per hectare (5 lbs. per acre) is regarded as adequate treatment. Forty five kilograms (one hundred pounds) of copper sulphate at $1.32 per kilogram ($0.60 per pound) will cover the treatment cost for Lake 106, a 8.1 hectare (20 acre) lake.

Fixed costs

1. Commercial Fish Farming Licence: A licence is required from the fish farming enterprise for the commercial sale of rainbow trout. In Manitoba a commercial fish farming licence costs $15.00.

2. Unemployment Insurance Commission, Canada Pension Plan and Worker's Compensation: An

employer is required to contribute to an employee's unemployment insurance, Canada Pension Plan and Worker's Compensation on the basis of wages paid to the employee. In addition, an employer is required to contribute to his own Canada Pension Plan. Based on a minimum wage rate of $2.15 the employer is required to contribute to the Canada Pension Plan at the rate of $0.03 per hour. Contributions to U.I.C. are based on $0.03 per hour x 1.4, and contributions to Worker's Compensation are calculated on the basis of $1.10 for each $100 dollars paid to an employee.

3. Insurance: Insurance premiums for major capital assets (boat and motor), which may be provided as a "rider" to a farm insurance policy, are based on two percent of the purchase price of capital investments totalling $1,960 dollars.

Depreciation

Depreciation is a system of accounting that distributes the cost of an asset over its estimated useful life. The following depreciation calculations are based on a declining balance at rates consistent with the Federal Income Tax Act:

1. Boat: A fourteen foot "John Boat", favoured by the aquaculture staff of the Freshwater Institute, retailed in Winnipeg for $518 (including sales tax) in 1975. A boat is categorized as a class 7 asset and is depreciated at 15 percent per year.

2. Outboard Engine: A 9.9 horsepower Johnson engine retailed for $771 (including sales tax) in Manitoba in 1975. An outboard engine is categorized as a class 10 asset and may be depreciated at 30 percent per year.

3. Gill Nets: The price of a 50 yard, 30 mesh, 210/2 nylon twine gill net, complete with floats and lead line, approximates $34.00 per net. Total investment, based on fifteen nets, equals $510.00. Nets are categorized as a class 8 asset and are depreciated at a rate of 20 percent per year.

4. Fish Tubs: Ten plastic tubs, required to carry nets, fish and ice, represent an investment of $83.00. Fish tubs are regarded as a class 8 asset and are also depreciated at 20 percent per year.

5. Ice Fishing Equipment: In the event that ice fishing is necessary, an additional investment in a "jigger" and an ice chisel is required, totalling $77.00. This equipment is also classified as class 8 and is depreciated at 20 percent per year.

ANALYSIS OF INCOME STATEMENT

The income statement evaluates the financial position and the profitability of an enterprise's annual operations.

Net profit

Referring to Table 1, it will be noted that net profit before tax is $1,205 in 1974 and $586 in 1975. The enterprise was able to cover its total accounting costs and provide a net profit. There are a number of profitability indices that will provide a measure of profit. It must be cautioned, however, that the importance of such indices is best assessed in comparison to alternative opportunities for labour and capital. For example, while a fish farming enterprise may appear profitable from an accounting point of view, such a measure of profitability should be compared to an alternative such as investing the same amount of labour and capital in a traditional farming venture such as increased beef production. Two familiar ratios follow:

1. Sales Margin: The sales margin relates net income to sales. It is calculated by dividing net profit after tax into sales:

   1974: $904/$3,722 = 24.29 percent
   1975: $439/$3,059 = 14.35 percent

   These margins are compared to the margins of retail and wholesale business in Table 2.

Table 2. Net profit on net sales.

Business	Upper Quartile Percent	Median Percent	Lower Quartile Percent
Retail			
Grocery Stores	1.72	1.00	0.53
Wholesale			
Dairy Products	2.79	1.32	0.71
Meat and Meat Products	1.61	0.67	0.22
Poultry and Poultry Products	3.87	1.29	0.38

The ratios of net income to net sales of the fish farming enterprise are considerably greater than those of the selected retail and wholesale business, indicating that the firm's sale price is high or its costs are low. It should be noted that with a 24 percent margin, unit sales can decline by 24 percent before the firm suffers an overall loss. This margin provides protection against losses due to declining prices.

2. Productivity of Assets: Productivity of assets measures the rate of return on the assets of the firm. It is calculated by dividing net income after tax by tangible net worth. For the fish farming enterprise, tangible net worth is estimated by total depreciated fixed assets:

   1974: $904/$1,516 = 59.63 percent
   1975: $439/$1,181 = 37.17 percent

   These profitability ratios are compared to net profits on tangible net worth for selected retail and wholesale business in Table 3.

"Generally, a relationship of at least 10 percent is regarded as a desirable objective for providing dividends plus funds for future growth"

Table 3. Net profit on tangible net worth.

Business	Upper Quartile Percent	Median Percent	Lower Quartile Percent
Retail			
Grocery Stores	17.98	11.57	6.30
Wholesale			
Dairy Products	20.64	13.33	4.85
Meat and Meat Products	17.12	11.06	6.75
Poultry and Poultry Products	27.05	14.28	4.38

(Dun and Bradstreet 1975).

The productivity of the fish farming enterprise again would appear to be considerably greater than the productivity ratios for the selected industries. A note of caution, however, is required. The current price of rainbow trout is undoubtedly a reflection of a relatively large potential market and a small volume of production. As production increases over time, the price at which the volume produced will clear the market will undoubtedly be reduced. The above-noted ratios can be expected to fall until they are in equilibrium with alternative food products. If for example, the price of fish decreased or the cost of production increased by 20 percent, the profitability indices for the trout farming enterprise would change accordingly:

1.	Sales Margin	1974:	9.3%
		1975:	.6%
2.	Productivity of Assets	1974:	22.8%
		1975:	1.6%

Cash flow

Referring to Table 1, the cash flow is calculated by adding to net income after tax, depreciation and interest expense. Depreciation, an accounting convention, distributes the cost of an investment over time at a zero interest rate. Interest expenses consider only the cost of borrowed capital. The cash flow provides a measure of the amount of money generated, after all other costs have been deducted, to repay the cost of total investments. As will be discussed in section 5, the cash flow provides an important method of assessing the profitability of an enterprise over an investment period. The cash flow for 1974 and 1975 was $1,347 and $774, respectively (no financing has been assumed, hence there is no interest expense). These sums of money are available to cover the cost of total investments.

Cash balance

In the short run, the cash balance is probably more relevant than the cash flow. The cash balance is calculated by adding to net income after tax, depreciation plus salary, less loan principal repayments. Depreciation is in reality a non-cash outlay. Similarly, the salary to the entrepreneur, the fish farmer, is a non-cash outlay in the sense that it is a payment to himself. Principal repayment on the other hand, which is not included as a deduction in the income statement, is a cash outlay. From this point of view, the cash balance reflects the actual amount of cash a fish farmer receives annually from an enterprise to pay for his investments and his labour. The cash balance for 1974 and 1975 was $1,817 and $1,204 respectively.

SUMMARY AND CONCLUSIONS

From an annual accounting point of view, the fish farming enterprise may be regarded as being in a financially viable position. Net profits, cash flows and cash balances are positive, and the profitability indices are considerably greater than alternative food industries. It will be noted, however, that profitability is very sensitive to changes in prices, costs and levels of production. As explained previously, the evaluation of an income statement represents an immediate judgement of financial viability. Profitability over an investment period, to be analyzed in a following section, is also of considerable importance.

BREAK-EVEN ANALYSIS ON ANNUAL PRODUCTION

Break-even analysis on annual production is used to determine the level of annual harvest at which revenue from the sale of rainbow trout will just cover the fixed and variable costs of annual production. If an enterprise has no fixed costs, the problem of a break-even production does not arise. However, to the extent that fixed costs exist, an enterprise will be in a financial loss position until a certain volume of production is reached. In the break-even analysis that follows, variable costs are those costs which are incurred in actual harvesting operations (refer to the Income Statement, Table 1). Fixed costs include pre-harvest costs, indirect costs and depreciation expenses.

OPERATING YEAR: 1974

Table 4 summarizes the fixed costs and variable costs, revenues and profits (or losses) associated with various levels of production for the 1974 operating year. The average variable cost has been calculated at $92.02 per 100 kilograms ($41.74 per hundred pounds) of production of 1,299 kilograms (2,863 pounds) of dressed fish. Percentage recovery has been determined by extrapolating the total harvest of 9,524 rainbow trout, totalling 1,299 kilograms (2,863 pounds) of dressed weight, to the maximum production potential of 12,000 stocked fingerlings. It will be noted that the break-even point lies between 453 and 681 kilograms (1,000 and 1,500 pounds) of fish. The precise break-even point may be determined by the following formula:

$$Q = \frac{F}{P-V} \text{ at break-even } Q$$

P = sales price per unit, ($2.87/kilogram: $1.30/pound)

Q = quantity produced and sold

F = fixed costs ($1,322)

V = variable cost per unit (0.9202 per kilogram; $0.4174 per pound)

$$Q = \frac{\$1,322}{\$1.30-\$0.4174} = 680 \text{ kilograms (1,498 pounds)}$$

Break-even production is 41.53 percent of stocked fingerlings. This volume must be harvested if costs are to be covered. Figure 4 illustrates the break-even analysis for 1974.

OPERATING YEAR: 1975

Table 5 summarizes the fixed costs and variable costs, revenues and profits (or losses) associated with various levels of production for the 1975 operating year. Variable costs have been calculated at $88.74 per 100 kilograms ($40.25 per hundred pounds) of production, based on a total production of 1,096 kilograms (2,416 pounds of dressed fish). Percentage recovery has been determined by extrapolating the total harvest of 8,028 rainbow trout, totalling 1,096 kilograms (2,416 pounds) of dressed weight, to the maximum potential of 12,000 stocked fingerlings. It will be noted that the break-even point lies between 681 and 907 kilograms (1,500 and 2,000 pounds) of fish. The precise break-even point is:

$$Q = \frac{F}{P-V} \text{ at break-even } Q$$

P = $2.87 per kilogram ($1.30 per pound)

F = $1,343

V = $1.08 per kilogram ($0.48 per pound)

$$Q = \frac{\$1,343}{\$1.30-\$0.4803} = 743 \text{ kilograms (1,638 pounds)}$$

Break-even production is 44.38 percent of stocked fingerlings. Figure 5 illustrates the break-even analysis for 1975.

SUMMARY AND CONCLUSIONS

During the 1974 operating season, actual production from Lake 106 approximated a 79 percent recovery. This compared favourably with the break-even requirement of 42 percent. Similarly, the actual production in 1975 of 64 percent is greater than the break-even requirement of 44 percent. To the extent that revenues and costs associated with different lakes and fish farming enterprises will differ, it is dangerous to apply the above analysis indiscriminantly to all lakes. An accounting system for individual enterprises is required. Finally, certain people engage in fish farming as a hobby. From this point of view, they may wish to disregard many cost components. It must be stressed, however, that if commercial fish farming is to be undertaken as a business, all cost components should be considered.

Table 4. Break-even on annual production: 1974.

Annual Production* (Kilograms)	(Pounds)	Percentage Recovery (%)	Variable Costs ($)	Fixed Costs ($)	Total Costs ($)	Total Income ($)	Net Profit (Loss) ($)
227	500	14.0	209	1,322	1,531	650	(926)
454	1,000	28.0	417	1,322	1,739	1,300	(439)
680	1,498	41.5	625	1,322	1,947	1,947	0
681	1,500	42.0	626	1,322	1,948	1,950	2
907	2,000	55.0	835	1,322	2,157	2,600	443
1,134	2,500	69.0	1,043	1,322	2,335	3,150	885
1,299	2,863	79.0	1,195	1,322	2,517	3,722	1,205
1,361	3,000	83.0	1,252	1,322	2,574	3,900	1,326
1,588	3,500	97.0	1,461	1,322	2,783	4,550	1,767
1,636	3,607	100.0	1,506	1,322	2,828	4,689	1,861

*Dressed fish: 136.3 grams (.3006 pounds) per fish

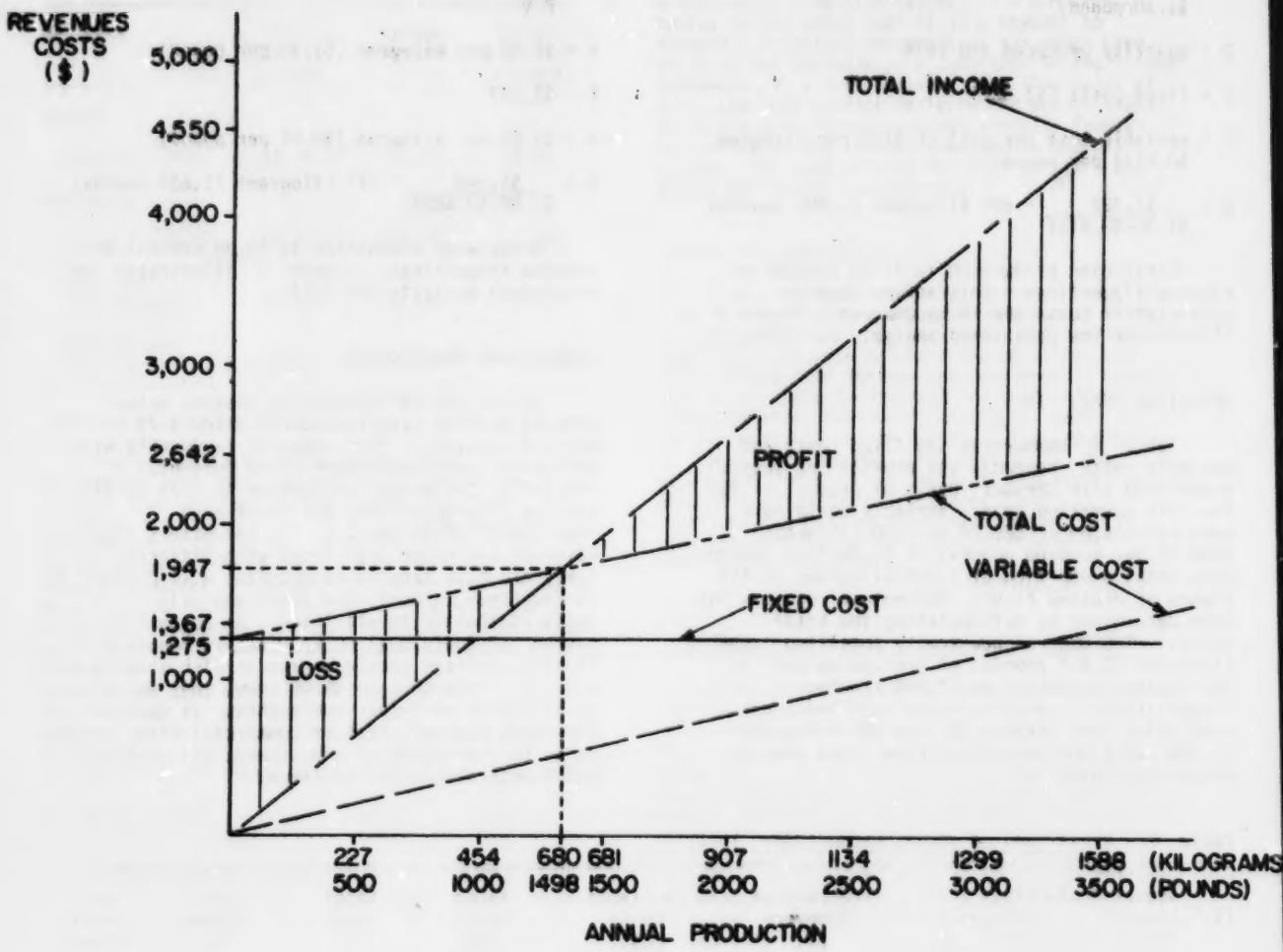

Fig. 4. Annual break-even production, 1974.

Table 5. Break-even on annual production: 1975.

Annual Production* (Kilograms)	(Pounds)	Percentage Recovery (%)	Variable Costs ($)	Fixed Costs ($)	Total Costs ($)	Total Income ($)	Net Profit (Loss) ($)
227	500	14.0	240	1,343	1,583	650	(933)
454	1,000	27.0	480	1,343	1,823	1,300	(523)
681	1,500	41.0	720	1,343	2,063	1,950	(113)
743	1,638	44.4	787	1,343	2,130	2,130	0
907	2,000	54.0	960	1,343	2,303	2,600	297
1,067	2,353	64.0	1,130	1,343	2,473	3,059	586
1,134	2,500	68.0	1,201	1,343	2,544	3,250	706
1,301	3,000	81.0	1,441	1,343	2,784	3,900	1,116
1,588	3,500	95.0	1,681	1,343	3,024	4,550	1,526
1,675	3,692	100.0	1,773	1,343	3,116	4,696	1,580

*Dressed fish: 140 grams (.3088 pounds) per fish

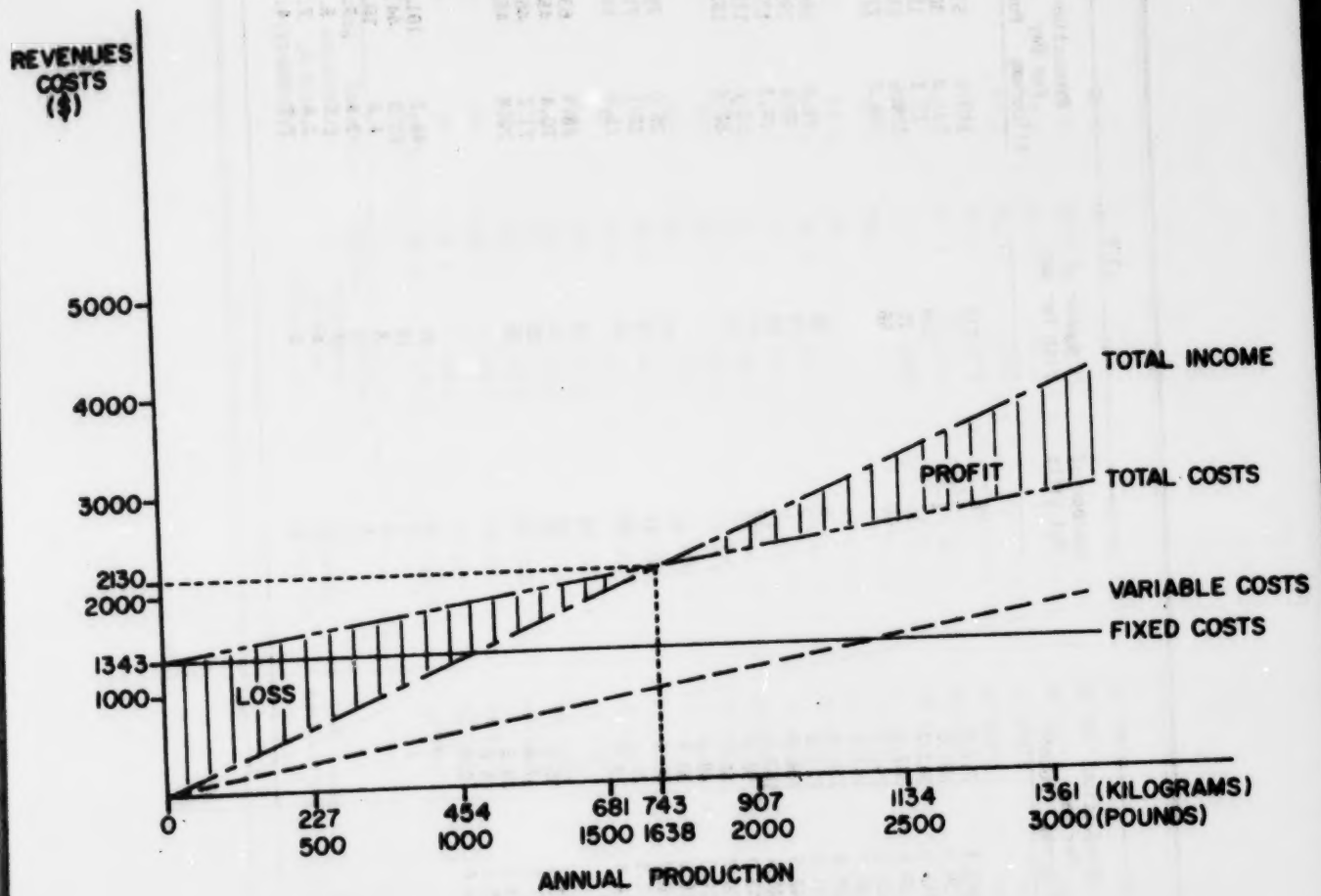

Fig. 5. Annual break-even production, 1975.

BREAK-EVEN ANALYSIS ON PRODUCTION PER UNIT OF FISHING EFFORT

As discussed previously, the harvest of fish diminishes with each successive daily set and lift of the gill nets over the harvest period. As a result, total production increases at a decreasing rate. This phenomenon is illustrated in Table 6 for the 1974 and 1975 operating years. During the 1974 operating year, fishing effort (nets per set-lift) was held constant at ten nets until the latter part of the harvest season. In 1975, the number of nets was varied in the daily harvest.

In estimating the break-even point on production per unit of fishing effort it is necessary that the daily value of production cover the daily variable cost of harvesting. In this situation, total revenue, which increases at a decreasing rate, and harvest costs (variable costs) are the important variables. Pre-harvest costs, indirect costs and depreciation expenses are regarded as "sunk" costs and do not enter into the criteria for the determination of the point at which fishing is terminated.

OPERATING YEAR: 1974

Table 7 summarizes production, revenue costs and profits associated with harvesting Lake 106 in 1974. From an economic point of view, fishing should terminate when the cost of an incremental unit of production (marginal) factor cost) exceeds the value of an incremental unit of production (marginal revenue product). In 1974, this situation occurred, initially, on October 16th after 15 days of harvesting. Referring to Table 7 , it will be noted that the cost of an additional unit of production, $4.54 per kilogram ($2.06/lb.) exceeded the value of an additional unit of production, $2.87 per kilogram ($1.30/lb.). This situation is reflected in the relationship of daily variable costs ($29.64) to the daily value of production ($18.72), and in the net profit of the enterprise ($1,159.25). Thus, harvesting operations should not have been conducted on October 17th and 18th. An interesting phenomenon, however, has been observed in the harvesting of pot-hole lakes. If, following a number of days of intensive fishing with declining catch per unit of fishing effort, harvesting is terminated and resumed at a later date, the catch per unit of fishing effort will often increase, as was evident

Table 6. Production per unit of fishing effort.

Harvest Days	1974				1975			
	Number of Net Lifts	Number of Fish Per Net	Production Per Day Kilograms	Production Per Day Pounds	Number of Net Lifts	Number of Fish Per Net	Production Per Day Kilograms	Production Per Day Pounds
September 29								
September 30	10	187	343.4	757.0	6	212	243.8	537.4
October 1	10	99	175.5	387.0	6	142	137.8	303.8
October 2	10	89	155.9	343.7	4	109	71.1	156.8
October 3	10	91	159.9	352.6	10	75	129.5	285.5
October 4	10	76	132.3	291.7	10	56	124.2	273.8
October 5	10	70	116.7	257.2				
October 6	10	64	108.4	238.9	9	46	75.6	166.7
October 7	10	61	101.5	223.8	7	78	90.6	199.7
October 8	10	29	48.5	106.9	9	48	79.4	175.0
October 9	10	27	46.4	102.4	10	41	52.2	115.1
October 10	10	29	43.9	96.8	12	32	62.4	137.6
October 11	10	18	30.3	66.7				
October 14	10	17	21.8	48.0				
October 15	10	10	14.0	30.9	10	20	36.0	79.4
October 16	10	6	8.2	18.0	10	18	32.2	71.0
October 17	10	6	10.3	22.7	10	15	25.6	56.5
October 18	10	6	8.4	18.5				
October 21					10	20	28.9	63.8
October 22					10	15	20.4	45.0
October 23	15	30	43.1	95.0	10	15	21.2	46.7
October 24	15	12	17.0	37.4	10	15	20.8	45.8
October 25	16	9	13.5	29.8				
October 29	13	14	20.6	45.6				
October 30	13	2	3.6	8.0				
November 28					6	39	46.2	101.9
November 30					6	18	20.0	44.2
December 1					6	4	4.6	10.1
December 2					6	3	3.4	7.5
December 3					6	2	2.5	5.6
December 4					6	4	3.4	7.5
December 5					6	2	2.2	4.9

Table 7. Costs and returns, Lake 106, 1974.

Date	Daily Value of Production	Daily Variable Cost of Production	Accumulated Value of Production	Accumulated Variable Cost of Production	Accumulated Total Cost	Net Profit (Loss)	Incremental Value of Production		Incremental Cost of Production	
							Kilograms	Pounds	Kilograms	Pounds
September 30	$787.28	$146.24	$787.28	$146.24	$1,468.24	$-680.96	$2.87	$1.30	$.53	$.24
October 1	402.48	92.09	1,189.76	238.33	1,560.33	-370.57	2.87	1.30	.66	.30
October 2	357.50	85.43	1,547.26	323.76	1,645.76	-98.50	2.87	1.30	.68	.31
October 3	366.60	84.00	1,913.86	407.76	1,729.76	184.10	2.87	1.30	.66	.30
October 4	303.42	75.04	2,217.28	482.80	1,804.80	412.48	2.87	1.30	.71	.32
October 5	265.54	73.18	2,484.82	555.98	1,877.98	606.84	2.87	1.30	.78	.36
October 6	248.43	71.18	2,733.25	627.16	1,949.16	784.09	2.87	1.30	.82	.37
October 7	232.70	68.75	2,965.95	695.91	2,017.91	948.04	2.87	1.30	.85	.38
October 8	111.15	49.45	3,077.10	745.36	2,067.36	1,009.74	2.87	1.30	1.28	.58
October 9	106.47	46.61	3,183.57	791.97	2,113.97	1,069.60	2.87	1.30	1.25	.57
October 10	100.62	46.61	3,284.19	838.58	2,160.58	1,123.61	2.87	1.30	1.33	.60
October 11	69.42	46.61	3,353.61	884.91	2,206.91	1,146.70	2.87	1.30	1.82	.83
October 14	49.92	29.64	3,403.53	913.83	2,235.83	1,167.70	2.87	1.30	1.70	.77
October 15	32.11	29.64	3,435.64	943.47	2,265.47	1,170.17	2.87	1.30	2.64	1.20
October 16	18.72	29.64	3,454.36	973.11	2,295.11	1,159.25	2.87	1.30	4.54	2.06
October 17	23.66	31.71	3,478.02	1,004.82	2,326.82	1,151.20	2.87	1.30	3.84	1.74
October 18	19.24	31.71	3,497.26	1,036.52	2,358.52	1,138.74	2.87	1.30	4.72	2.14
October 23	98.80	35.94	3,596.06	1,072.46	2,394.46	1,201.60	2.87	1.30	1.04	.47
October 24	38.87	29.64	3,634.93	1,102.10	2,424.10	1,210.83	2.87	1.30	2.19	.99
October 25	30.94	27.76	3,665.87	1,130.06	2,452.06	1,213.81	2.87	1.30	2.57	1.17
October 29	47.45	33.39	3,713.32	1,163.45	2,485.45	1,227.87	2.87	1.30	2.02	.91
October 30	8.32	31.51	3,721.64	1,195.15	2,517.15	1,204.49	2.87	1.30	10.85	4.92

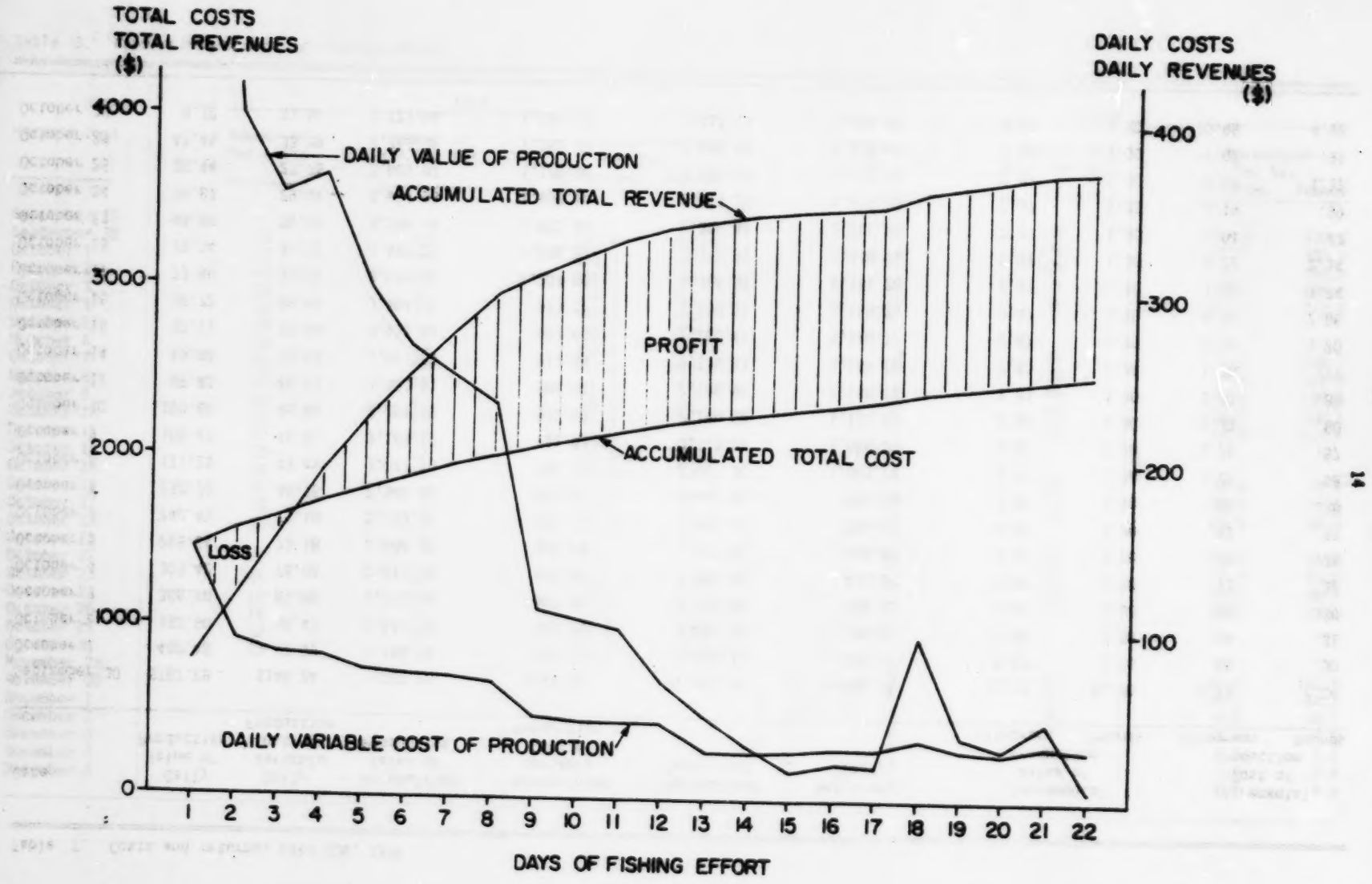

Fig. 6. Daily break-even, 1974.

on October 23rd and 29th. It will be noted, in reference to Tables 6 and 7 , that after a period of no fishing effort, production increased sufficiently that the value of an incremental unit of production exceeded the cost of an incremental unit of production until the final day of harvesting on October 30th. Figure 6 illustrates graphically the relationship of the daily cost and value of production. The point of greatest net profit was reached on the 21st day of fishing.

OPERATING YEAR: 1975

Production revenues, costs and profits for Lake 106 in 1975 are presented in Table 8 Based on the premise that harvesting operations should terminate when the cost of an incremental unit of production exceeds the value of an incremental unit of production, harvesting should have terminated for the season after 20 days of fishing. At this point the enterprise would have generated the greatest net profit. Referring to Table 8 , it can be seen that net profit declines from its maximum on day 19 of $673.16 each day to $585.55 on day 24. This is illustrated graphically in Figure 7.

SUMMARY AND CONCLUSIONS

The foregoing analysis has demonstrated the extent to which net profits may be maximized by terminating harvesting operations when the incremental cost of production equals or exceeds the value of production. Referring to Table 7 net profit is greatest on October 29, after 21 days of fishing. In 1975, net profit is maximized on November 30, after 19 days of fishing. The important variables to consider in this assessment are the daily variable costs associated with harvesting and the daily value of production.

ANALYSIS OF INVESTMENT IN AQUACULTURE

PROFORMA STATEMENT

A ten year proforma statement related to the operation of Lake 106 is presented in Table 9 The proforma statement, analogous to an income statement, provides an annual "snapshot" of accounting and financial performance. However, whereas an income statement records historic performance, the proforma statement presents anticipated income receipts and operating expenses over a proposed investment period. It is an important tool for analysing expected revenues and costs in making investment decisions.

PROJECTED PRODUCTION

Given the variability of yield in pot-hole lakes, the two years of production (1974 and 1975) from Lake 106 provide insufficient observations on which to predict future production. However, based on observations of several lakes over a number of years, it has been observed that the yield of "non-algal collapse" lakes is relatively consistent, and the average standard deviation of survival for such lakes has been calculated to be ±14.4 percent (Ayles and Barica 1977). Based on a single observation of survival, therefore, there is a 68 percent probability that a non-algal collapse lake will produce within ±14.4 percent of initial production, and a 95 percent probability that a lake will produce within ±28.8 percent of initial production (Ayles and Barica 1977).

The mean survival from Lake 106, which is classified as a non-algal collapse lake, has approximated 72 percent (79% in 1974 and 64% in 1975). Assuming that the above observations follow a normal distribution, future production from Lake 106 could be expected to be within ±28.8 percent of the mean production 95 percent of the time. It is interesting to note that the expected level of production will cover the break-even requirements of Lake 106. Based on break-even requirements of 43 percent recovery of stocked fingerlings, Lake 106 can be expected, at the very minimum, to break-even 95 percent of the time. This situation provides considerable flexibility in projecting anticipated production. For purposes of estimating expected returns to investments in aquaculture, it is anticipated that annual production over a ten year period will average 8,600 rainbow trout with a dressed weight of 1,179 kilograms (2,600 pounds). These estimates are based on an annual recovery of 72 percent of stocked fingerlings (12,000 rainbow trout fingerlings) and an average weight of 136 grams (0.30 pounds) per dressed fish. Annual production in Table 9 has been projected using random normal numbers with a mean of 72 percent and a standard deviation of ±14.4 percent.

REVENUE AND COST COMPONENTS

The revenue and cost components of the proforma statement (Table 9) are based on those presented in the income statements (Table 1). Escalation factors have been applied to reflect changing prices by extrapolating wholesale and retail price indices. A brief description of the changing revenue and cost components follow:

Trout sales

During the 1975 harvest season the selling price for rainbow trout, through private sale, approximated $2.87 per kilogram ($1.30 per pound) for dressed fish. An escalation factor of two percent has been applied based on price series data for fish as established by the Freshwater Fish Marketing Corporation. As explained previously, as production of rainbow trout from prairie pot-hole lakes increases over time, the price of the trout, such that all production will clear the market, will undoubtedly be less than $2.87 per kilogram ($1.30 per pound). For this reason, if a rainbow trout farming industry develops, price expectations must be reduced accordingly.

Labour costs

The minimum wage rate of $2.15 per hour has been projected, using an escalation factor of six percent per year in accordance with the federal anti-inflation guidelines.

Table 8. Costs and returns, Lake 106, 1975

	Daily Value of Production	Daily Variable Cost of Production	Accumulated Value of Production	Accumulated Variable Cost of Production	Accumulated Total Cost	Net Profit (Loss)	Incremental Value of Production		Incremental Cost of Production	
							Kilograms	Pounds	Kilograms	Pounds
September 29	$558.90	$101.99	$558.90	$101.99	$1,444.99	$-886.09	$2.87	$1.30	$.53	$.34
September 30	315.95	79.17	874.85	181.16	1,524.16	-649.31	2.87	1.30	.73	.33
October 1	163.67	57.33	1,037.93	238.49	1,581.49	-543.56	2.87	1.30	1.01	.46
October 2	296.92	76.04	1,334.84	314.53	1,657.53	-322.69	2.87	1.30	.73	.33
October 3	284.70	62.65	1,619.54	377.18	1,720.18	-100.64	2.87	1.30	.64	.29
October 6	173.37	57.96	1,792.91	435.14	1,778.14	14.77	2.87	1.30	.95	.43
October 7	207 69	66.14	2,000.60	501.28	1,844.28	156.32	2.87	1.30	.90	.41
October 8	152.00	60.48	2,182.60	562.24	1,905.24	277.36	2.87	1.30	.95	.43
October 9	119.70	57.04	2,302.30	618.80	1,951.80	350.50	2.87	1.30	1.37	.62
October 10	143.10	55.72	2,445.40	674.52	2,017.52	427.88	2.87	1.30	1.12	.51
October 15	82.85	34.39	2,527.98	708.91	2,051.91	476.07	2.87	1.30	1.19	.54
October 16	73.84	34.38	2,601.82	743.29	2,086.29	515.53	2.87	1.30	1.32	.60
October 17	55.76	45.61	2,660.58	788.90	2,131.90	528.68	2.87	1.30	2.23	1.01
October 21	66.35	34.39	2,726.93	823.29	2,166.29	560.64	2.87	1.30	1.48	.67
October 22	46.80	33.38	2,773.73	856.67	2,199.67	574.06	2.87	1.30	2.05	.93
October 23	48.57	33.39	2,822.30	890.06	2,233.06	589.24	2.87	1.30	1.96	.89
October 24	47.63	33.38	2,869.93	923.44	2,266.44	603.49	2.87	1.30	2.01	.91
November 28	105.98	35.16	2,975.91	958.66	2,301.66	674.25	2.87	1.30	.90	.41
November 30	45.97	30.90	3,021.88	989.56	2,332.56	689.32	2.87	1.30	1.92	.87
December 1	10.50	26.66	3,032.38	1,016.22	2,359.22	673.16	2.87	1.30	7.25	3.29
December 2	7.80	26.66	3,040.18	1,042.88	2,385.88	654.30	2.87	1.30	9.79	4.44
December 3	5.82	26.66	3,046.00	1,069.54	2,412.54	633.46	2.87	1.30	13.05	5.92
December 4	7.80	30.41	3,053.80	1,099.95	2,442.95	610.85	2.87	1.30	11.18	5.07
December 5	5.10	30.40	3,058.90	1,130.35	2,473.35	585.55	2.87	1.30	17.20	7.80

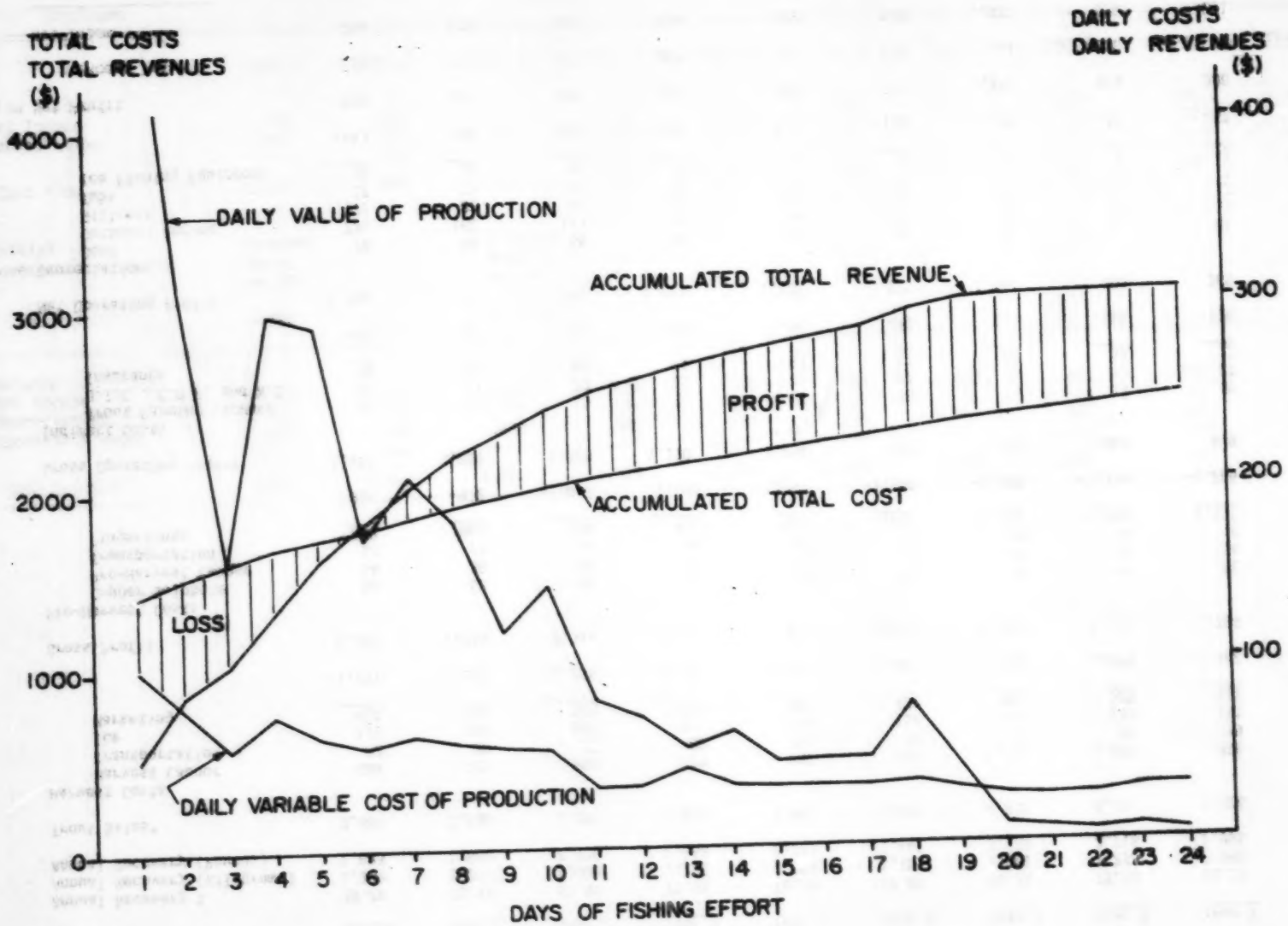

Fig. 7. Daily break-even, 1975.

Table 9. Rainbow trout farming 10 year proforma statement, projected recoveries Lake 106.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Annual Recovery %	78.7%	73.9%	67.4%	71.0%	76.3%	67.8%	90.7%	75.5%	58.2%	52.9%
Annual Recovery (Kilograms)	1,308	1,207	1,000	1,159	1,246	1,107	1,481	1,233	950	864
Annual Recovery (Pounds)	2,883	2,660	2,426	2,556	2,747	2,441	3,265	2,718	2,095	1,904
Trout Sales*	3,683	3,538	3,299	3,553	3,901	3,539	4,832	4,104	3,226	2,989
Harvest Costs										
Harvest Labour	684	721	698	779	887	836	1,185	1,046	855	824
Transportation	83	80	75	82	91	83	115	98	79	73
Ice	110	107	102	111	125	116	161	139	111	105
Marketing	414	404	383	419	467	432	601	520	417	344
	-1,291	-1,312	-1,258	-1,391	-1,570	-1,467	-2,062	-1,803	-1,462	-1,346
Gross Profit	2,392	2,226	2,041	2,162	2,331	2,072	2,770	2,301	1,764	1,643
Pre-Harvest Costs										
Copper Sulphate	60	62	65	67	70	73	76	79	82	85
Pre-Harvest Labour	34	36	38	40	43	45	48	51	54	57
Transportation	13	13	14	14	15	15	16	16	16	17
Fingerlings	828	861	896	931	969	1,007	1,048	1,090	1,133	1,179
	-935	-972	-1,013	-1,052	-1,097	-1,140	-1,188	-1,236	-1,235	-1,338
Gross Operating Profit	1,457	1,254	1,028	1,110	1,234	932	1,582	1,065	479	305
Indirect Costs										
Trout Farming Licence	15	15	15	15	15	15	15	15	15	15
U.I.C., C.P.P. and W.C.	21	23	23	25	28	27	38	33	27	27
Insurance	39	42	45	49	53	57	62	67	72	78
	-75	-80	-83	-89	-96	-99	-115	-115	-114	-120
Net Operating Profit	1,382	1,174	945	1,021	1,138	833	1,467	950	365	185
Depreciation										
Boat	78	66	56	48	41	34	29	25	21	18
Outboard Engine	231	162	113	79	56	39	27	19	13	9
Gillnets	102	82	65	52	42	33	27	21	17	14
Tubs	17	13	11	8	7	5	4	3	3	2
Ice Fishing Equipment	15	12	10	8	6	5	4	3	3	2
	-443	-335	-255	-195	-152	-116	-91	-71	-57	-45
Net Profit	939	839	690	826	986	717	1,376	879	308	140
Income Tax	235	210	173	207	247	179	344	220	77	35
Net Income	704	629	517	619	739	538	1,032	659	231	105

*Fish prices are escalated at 2% per annum

Table 9. Continued

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cash Flow Analysis										
Net Income	704	629	517	619	739	538	1,032	659	231	105
Depreciation	443	335	255	195	152	116	91	71	57	45
Total Cash Flow	1,147	964	772	814	891	654	1,123	730	288	150
Initial Investment = $1,959	Present Value at 10%		Internal Rate of Return							
	4,994		47.0210%							
Cash Balance										
Net Income	704	629	517	619	739	538	1,032	659	231	105
Depreciation	443	335	255	195	152	116	91	71	57	45
Operator's Wages	439	463	448	500	570	536	761	671	549	528
Total Cash Balance	1,586	1,427	1,220	1,314	1,461	1,190	1,884	1,401	837	678

Transportation

Transportation costs of $0.10 per kilometer ($0.16 per mile) have been projected using an escalation factor of three percent per year based on the Consumer Price Index for Transportation Services (Finance Canada 1975).

Ice

Ice costs of $0.07 per kilogram ($0.03 per pound) have been projected using an escalation factor of four percent per year based on the General Consumer Price Index (Finance Canada 1975).

Marketing

The labour ($2.15 per hour) and transportation costs $0.10 per kilometer ($0.16 per mile) associated with the marketing of rainbow trout have been projected using escalation factors of six and three percent per year respectively.

Copper sulphate

The General Consumer Price Index (Finance Canada 1975) has been used as a basis to project the cost of copper sulphate at an escalation rate of four percent per year.

Fingerlings

The 1975 cost of fingerlings ($69.00 per thousand) has been projected using an escalation factor of four percent per year based on the General Consumer Price Index (Finance Canada 1975).

Unemployment Insurance Commission, Canada Pension Plan and Worker's Compensation

U.I.C., C.P.P. and W.C. have been projected using an escalation factor of six percent per year in accordance with the cost of labour.

Insurance

The cost of insurance has been projected using an escalation factor of eight percent per year on the basis of the Services Index (Finance Canada 1975).

ANALYSIS OF PROFORMA STATEMENT

Net profit

Referring to Table 9 , it will be noted that net profit before tax is positive during each year of the projected ten year investment period. It is apparent that the variability in annual recovery has a considerable impact on net profit. Nevertheless, the enterprise is able to cover its annual accounting costs and provide a net return.

Cash flow

As explained previously, the cash flow is calculated by adding depreciation and interest expenses to net income after tax. The cash flow represents the amount of money generated each year, after all other costs have been deducted, to repay the cost of total investment. From this point of view, the annual cash flows provide the necessary information to evaluate the profitability of aquaculture over time. This is determined by calculating the present value of the cash flows.

Present value

The present value is calculated by discounting annual cash flows at an interest rate that reflects the cost of capital. This permits a person, interested in investing in aquaculture, to determine if fish farming will generate sufficient revenue to "pay-back" dollars invested. Referring to Table 10 , it will be noted that the present value of the cash flows, based on a cost of capital of 10 percent is $4,995, and $4,205 based on a cost of capital of 15 percent.

Table 10. Present value of cash flows.

Year	Cash Flow	P.W.F.* 10%	Present Value	P.W.F. 15%	Present Value
1	$1,147	.9091	$1,042	.8696	$997
2	946	.8264	797	.7561	729
3	772	.7513	580	.6575	508
4	814	.6830	550	.5718	465
5	891	.6209	553	.4972	443
6	654	.5645	369	.4323	283
7	1,123	.5132	576	.3759	422
8	730	.4665	341	.3269	239
9	288	.4241	122	.2834	82
10	150	.3855	58	.2472	37

	10%	15%
Present Value	4,994	4,205
Investment	1,959	1,959
Net Present Value	3,035	2,246

*Present Worth Factor

The present value may be compared with the initial investment ($1,960) to determine if the cash flows are greater or less than investment requirements in rainbow trout farming. If the present value is less than the investment requirements ($1,960) rainbow trout farming would be regarded as a poor investment. It will be noted that the present value ($4,995) is greater than the investment requirements ($1,960). The resultant net present value (present value minus investment requirements) provides an estimation of the value of the lake in rainbow trout production. It is an estimate of the price a fish farmer could pay for Lake 106.

SUMMARY AND CONCLUSIONS

The financial valuation of Lake 106 in rainbow trout production over a ten year period indicates that investment in aquaculture is feasible. Expected production and the resultant cash flows are sufficient to cover operating costs and repay investment outlays. That is, the present value of the lake in rainbow trout production is greater than the investment requirements. In addition, the net present value of the lake, the residual value after all factors of production have been paid, is positive.

A word of caution is required. The annual production from Lake 106 has generally exceeded the annual productive capacities of other aquaculture lakes (Ayles and Barica 1977). The extent to which pot-hole lakes in the prairie region can be expected to attain similar annual production will be largely contingent upon the successful elucidation of the biological parameters that affect annual recovery. In the event that annual recovery falls short of that experienced with Lake 106, there is a concern that a viable fish farming industry will ever become a reality. This situation is discussed briefly in the concluding chapter.

PROSPECTS FOR A FISH FARMING INDUSTRY

There is a concern that Lake 106 is not representative of the majority of pot-hole lakes found in the prairie provinces. Ayles and Barica (1977) have estimated that the mean recovery from non-algal collapse lakes is 36.2 percent. On the other hand, the production recorded on Lake 106 is representative of only five percent of the lakes for which information is presently available (Ayles and Barica, 1977). As such, the financial performance of Lake 106 is considered to present an exceptionally optimistic prospect for a fish farming industry at this point in time.

PROFORMA STATEMENT

In the interest of demonstrating the financial performance of fifty percent of the non-algal collapse lakes which have been studied to date, Table 11 presents a proforma statement based on a mean recovery of 36.2 percent. Annual production has been projected using random normal numbers, with a mean of 36.2 percent and a standard deviation of 14.4 percent. Revenue and cost data contained in Table 11 are based on those contained in Table 9 . It should be noted that the difference in harvest costs (variable costs calculated on the basis of per unit production) between the two tables reflects the difference in the amount of fishing effort required to harvest different levels of production. Fixed costs remain the same.

ANALYSIS OF PROFORMA STATEMENT

Net profit

Referring to Table 11, it will be noted that net profit before tax is negative in six out of ten years. In addition, the sum of the losses exceeds the sum of the profits. The enterprise is suffering an accounting loss over time. This situation can be examined more precisely by an evaluation of the cash flows.

Cash flow

Paralleling net profit, the cash flows are negative in six out of the ten year investment period. Despite the observation that the sum of the cash flows is positive, the sum is less than the initial investment ($1,960). As such, the enterprise is not generating a sufficient cash flow to pay for the required investments in aquaculture, and the rate of return on investment is negative.

Present value

Referring to Table 12, it will be noted that the present value of the cash flows at a zero interest rate is $460. At an interest rate of ten percent, the present value is $603. It would normally be expected that the present value at a zero interest rate would be greater than that calculated at a positive interest rate. This situation may be explained, however, by the timing and weighing of the negative and positive components of the cash flow. Regardless, when the initial investment is deducted from the present value, the net present value of the enterprise is negative. The enterprise cannot be considered as a viable proposition and investment in fish farming is not advisable under these circumstances.

Table 12. Present value of cash flows.

Year	Cash Flow	P.W.F.* 10%	Present Value	P.W.F. 15%	Present Value
1	$309	.9091	$-281	.8696	-269
2	539	.8264	445	.7561	408
3	581	.7513	437	.6575	382
4	934	.6830	672	.5718	563
5	-415	.6209	-258	.4972	-206
6	-154	.5645	87	.4323	-67
7	174	.5132	89	.3759	65
8	-724	.4665	-338	.3269	-237
9	-494	.4241	-210	.2843	-140
10	-43	.3855	-17	.2472	-11

	10%	15%
Present Value	452	488
Investment	-1,959	-1,959
Net Present Value	-1,507	-1,471

*Present Worth Factor

Table 11. Rainbow trout farming 10 year proforma statement, projected recoveries non-algal collapse lakes (mean = .3621).

	Year 1	Year 2	Year 3	Year 4	Year 5	ear 6	Year 7	Year 8	Year 9	Year 10
Annual Recovery %	22.1%	50.6%	53.0%	63.3%	23.8%	33.5%	45.6%	18.8%	27.9%	44.4%
Annual Recovery (Kilograms)	366	838	878	1,048	394	555	755	311	462	735
Annual Recovery (Pounds)	807	1,847	1,936	2,310	869	1,224	1,664	686	1,018	1,620
Trout Sales*	1,048	2,455	2,629	3,210	1,233	1,772	2,461	1,036	1,568	2,543
Harvest Costs										
Harvest Labour	192	466	517	655	261	390	562	246	386	652
Transportation	23	55	59	73	28	41	58	24	38	61
Ice	31	74	81	99	39	57	81	35	53	88
Marketing	116	277	301	374	146	213	302	129	200	331
	-362	-872	-958	-1,201	-474	-701	-1,003	-434	-677	-1,132
Gross Profit	686	1,583	1,671	2,009	759	1,071	1,458	602	891	1,411
Pre-Harvest Costs										
Copper Sulphate	60	62	65	67	70	73	76	79	82	85
Pre-Harvest Labour	34	36	38	40	43	45	48	51	54	57
Transportation	13	13	14	14	15	15	16	16	16	17
Fingerlings	828	861	896	931	969	1,007	1,048	1,090	1,133	1,179
	-935	-972	-1,013	-1,052	-1,097	-1,140	-1,188	-1,236	-1,285	-1,338
Gross Operating Profit	-249	611	658	957	338	-69	270	-634	-394	73
Indirect Costs										
Trout Farming Licence	15	15	15	15	15	15	15	15	15	15
U.I.C., C.P.P. and W.C.	6	15	17	22	9	13	19	8	13	23
Insurance	39	42	45	49	53	57	62	67	72	78
	-60	-72	-77	-86	-77	-85	-96	-90	-100	-116
Net Operating Profit	-309	539	581	871	-415	-154	174	-724	-494	-43
Depreciation										
Boat	78	66	56	48	41	34	29	25	21	18
Outboard Engine	231	162	113	79	56	39	27	19	13	9
Gillnets	102	82	65	52	42	33	27	21	17	14
Tubs	17	13	11	8	7	5	4	3	3	2
Ice Fishing Equipment	15	12	10	8	6	5	4	3	3	2
Total Depreciation	-443	-335	-255	-195	-152	-116	-91	-71	-57	-45
Net Profit	-752	204	326	676	-567	-270	83	-795	-551	-88
Income Tax	0	0	0	-113	0	0	0	0	0	0
Net Income	-752	204	326	789	-567	-270	83	-795	-551	-88

*Fish prices are escalated at 2% per annum

Table 11. Continued

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cash Flow Analysis										
Net Income	-752	204	326	789	-567	-270	83	-795	-551	-88
Depreciation	443	335	255	195	152	116	91	71	57	45
Total Cash Flow	-309	539	581	984	-415	-154	174	-724	-494	43
Initial Investment = $1,959		Present Value at 10%	Internal Rate of Return							
		452	.0000							
Cash Balance										
Net Income	-752	204	326	789	-567	-270	83	-795	-551	-88
Depreciation	443	335	255	195	152	116	91	71	57	45
Operator's Wages	123	131	317	420	168	250	361	158	248	418
Total Cash Balance	186	670	898	1,404	-247	96	535	-566	-246	375

SUMMARY AND CONCLUSIONS

Based on a mean production of 36.2 percent which has been experienced to date on non-algal collapse lakes, investment in rainbow trout fish farming as a commercial venture is not considered to be advisable. As indicated previously, the biological factors affecting annual recovery must be resolved before aquaculture is promoted.

To the extent that a person may wish to engage in rainbow trout farming as a hobby, the advisability of investing in fish farming is somewhat different. If a fish farmer wished to ignore his wages and the cost of investing in aquaculture, it is possible to cover operating costs and generate a small surplus income. Referring to Table 6.1, it will be noted that the cash balance over the ten year period is positive on seven occasions. It is apparent that while the hobbyist will occasionally suffer a negative cost outlay, over time he will generally receive a positive cash balance.

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